

Aspects of Science in Western Australia 1829-1979.  
A volume to commemorate the 150th Anniversary of the founding of Western Australia.

## History of geology in Western Australia

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### Abstract

Geology was of great interest to the early settlers because they realized that, if their new colony was ever to develop rapidly, something in addition to agriculture was required; hence the interest in locating economic mineral deposits. In the first 70 years geology was practised mainly by explorers and rarely by professional geologists, which the colony could only occasionally afford to employ. This situation changed with the first major mineral discovery—gold. Each major economic advance in Western Australia has stemmed from new mineral discoveries. This has resulted in the expansion of interest in and development of geology in government, academic and industrial fields.

### The beginning

In the development of Western Australia during the past 150 years all of the periods of major economic growth can be related to mineral discoveries. Geology has therefore played a major role in this development. Most of the original settlers came with expectations of a fertile land from which their own requirements could be met by agriculture and animal husbandry, but they soon realized that, apart from relatively small areas such as along the Swan and Greenough River valleys, the land was poor and their methods yielded a bare subsistence. Obviously something more was required to attract new settlers and to provide earnings to finance roads, schools, hospitals, harbours and other essential public works.

Fortunately among the settlers were men of vision who were prepared to look further afield, and who became explorers; together with the early surveyors, they ventured into the unknown interior in search of better prospects. While these persons were not trained geologists, they were in many cases very good observers and recorded the nature of the ground they traversed. Also, because of the struggle for survival in these early years, a few appreciated the advantages which would accrue to the young colony if economic minerals were discovered. As early as 1839 the Government offered a free grant of 1 036 hectares of land to the first person to discover a coal seam. Later a German naturalist, Preiss, reported finding coal on the Murray River. Specimens of this poor quality coal raised hopes, and rumours of the mineral potential of the colony were spread.

In September 1846, a prospectus to form a company (The Western Australian Mining Company) with a capital of \$40 000 was issued. This, and the persistent rumours, generated the first mineral boom for this State. To add to the

enthusiasm A. C. Gregory, the Assistant Surveyor General, and his brothers, F. T. and H. C. Gregory, reported the discovery of coal on the Irwin River on 9 September 1846 and claimed the free grant of land for the first discovery of coal.

The company commenced drilling near the Murray River and reached a depth of 12 m encountering some coal of doubtful quality. Through inexperience and shareholders who, (like those of today) were looking for quick returns, the company was soon in difficulties. In order to assess the potential, the company engaged Dr Ferdinand von Sommer, variously described as "mining expert", "eminent mineralogist", or "geologist". His remuneration was £6 per month with keep which amounted to £12 19s 2d per month at Leeders Hotel and the company horse. von Sommer arrived from Adelaide on 15 February 1847, accompanied by an experienced miner named Thomas.

The company was also interested in possible lead or copper deposits between the Canning and Serpentine Rivers, but the investigation for both coal and metallic minerals was unsuccessful. von Sommer's employment with the Western Australian Mining Company had lasted only a few months. In mid-1847 he was commissioned by the Governor to accompany the Surveyor General to examine the Gregory brothers' coal find on the Irwin River. It appears that von Sommer was the first professional geologist to work in Western Australia and the first employed by the Government. He travelled extensively for those days, examining the Victoria, Toodyay and York districts, the country between York and Mount Barren and the area from Doubtful Island Bay to Cape Naturaliste.

According to records this work was done in 1847 and 1848 and von Sommer wrote four reports to the Colonial Secretary which are

recorded in exploration diaries of the Lands Department. He contributed three papers to the geological literature of the day and three original drawings of his geological observations are preserved by the Geological Survey as the first known geological maps of Western Australia. von Sommer's later activities are unknown, and he left the colony in 1851.

The Gregory brothers, particularly A. C. and F. T., both of whom were in the department of the Surveyor General, carried out jointly and separately many exploratory expeditions between 1846 and 1862, first in southern Western Australia, then in the North-West, and later across northern Australia. They were keen observers and their records frequently describe the geology of the area over which they travelled. They had a good knowledge of geology and contributed papers to the Royal Geographical Society, of which they were Fellows.

In 1848 F. T. Gregory discovered lead and some copper in the bed of the Murchison River and this occurrence, named Geraldine, became the first lead mine in Western Australia. After an extensive exploration trip through the North-West, he reported "of mineral I was unable to discover any traces, except iron". A geological map of the colony by the Gregorys was published in London in 1860.

Due to the financial difficulties experienced by the young colony, it was not until 1870 that it was again possible to engage a geologist, namely H. Y. Lyle Brown. It would appear that he was given a two-year contract to report on the geology of the colony, as then settled or known. In his period of service Brown prepared three maps and ten reports on the areas he examined, which extended from the Murchison southwards along the coast to Doubtful Island Bay, and inland to the extent of the settled area. A geological map of this area was published on a scale of about 18 miles to an inch. He later became the Government Geologist of South Australia (1882-1912).

In April 1870, a clergyman/scholar the Reverend Charles Grenfell Nicolay arrived in Western Australia. He was a man of many parts with the ability to antagonize some people and please others. Nicolay, who was a Fellow of the Royal Geographical Society, had been associated with the King's and Queen's (now defunct) Colleges in London, having been largely responsible for founding the latter, where he was Professor of Geography and Ancient History. In Western Australia he apparently impressed the Governors of the day, and, besides his church duties, he became an adviser to the Government (1881-1889) on technical and scientific matters. His contributions to geology included an investigation of a ship canal from the sea to Rocky Bay on the Swan River to develop a major harbour at Fremantle (probably the first engineering geology done in this State), an investigation of the reports of coal in the bed of the Fitzgerald River, a "Handbook of Western Australia" (1881), the geology of the railway route between Guildford and Clackline (1887) and a circular on prospecting for gold (1886). He also prepared a rock and mineral collection

together with some notes on the geology of Western Australia for the Colonial and Indian Exhibition of 1886, a contribution to a commission enquiring into the water supply of Perth and Fremantle, and identifications of rocks and minerals. In 1881 he was authorized by Governor Robinson to establish at Fremantle a collection of rocks and minerals of the colony. Nicolay continued his many and varied interests in the colony until his death in 1897 at the age of 81.

After the departure of H. Y. Lyle Brown it was nine years before the colony could afford to employ a geologist again. E. G. Hardman of the Geological Survey of Ireland was appointed in 1882 and stayed until 1885 when the colony again could no longer afford the services of a geologist. Hardman concentrated his efforts on the Kimberley region and published two major reports on his field work. These stimulated the search for gold in this area, resulting in the first find of gold in the colony by Hall and party in 1885. The Government had offered a reward of \$20 000 to the discoverer of the first goldfield to produce 10 000 ounces. While the Kimberley find did not produce the required amount of gold, the Government paid \$1 000 reward each to Hardman and Hall. Hardman also examined and reported on the geology of the Bunbury and Blackwood River areas and on the water supply of Perth and Fremantle.

Hardman made a major contribution to the early geology of the State and returned to Ireland with an assurance that he would become Government Geologist when the Government could afford to make a permanent appointment. Unfortunately he died early in 1887, the year in which it was decided to make such an appointment.

H. P. Woodward, who had been Assistant Geologist to H. Y. Lyle Brown in South Australia, was appointed Government Geologist for a term of five years and commenced duty in January 1888. He had B. H. Woodward appointed as assayer and curator of the Geological Museum, while in 1894 S. Göczel was appointed as Field Geologist and Mining Engineer.

This was a very exciting period for Western Australia with gold discoveries being made progressively throughout the colony, commencing in the Kimberley in 1885 and culminating with Kalgoorlie in 1894. Woodward covered large areas of Western Australia and produced short reports on his observations for the Government. His major work was probably the Mining Handbook issued in 1894 with a second edition in 1895. This volume, 216 pages with maps, must have been extremely useful at that time because as well as a description of the physiography and geology, it contained a wealth of other information including the known mineral occurrences and resources, general information for prospectors, and shipping, railway, postal and telegraph information. Another accomplishment of Woodward was the first coloured geological map of the State published in 1894 by the Government.



The colony began to appreciate the value of competent geological advice through the efforts of Brown, Hardman and Woodward, particularly with the discovery of gold, which caused the first major development. Woodward's contract was extended to the end of 1895 when he resigned, as did his two assistants. Apparently there were better-paid positions available elsewhere in private enterprise. This resulted in a firm decision being made to establish a permanent Geological Survey in this State.

Until this period the knowledge and development of geology had been confined to the occasional Government Geologist employed by the colony and to dedicated explorers or surveyors, who had acquired a knowledge of geology by reading and experience. From this time geology was to be developed in Western Australia by three groups of geologists: those associated with Government Geological Surveys; the teachers and research workers in educational institutions; and consultants or geologists employed by companies.

#### Government geological surveys

Andrew Gibb Maitland was appointed as Government Geologist in charge of the first permanent State Geological Survey. He started work in November 1896 and established an office



Figure 1.—Andrew Gibb Maitland, the first Government Geologist in charge of a permanent Geological Survey.

with a staff of nine, including three geologists, a mineralogist, a topographic surveyor, a draftsman, a laboratory assistant, a cadet and a clerk/accountant.

By 1912 the professional staff had increased to ten; but later it decreased, until during the 1930s it averaged only three. It did not rise to ten again until 1959. From 1961 onwards a major expansion was approved and the number of staff grew rapidly until at the end of 1978 the establishment was 63 professional officers. The Government Geologists (now titled Director) in charge over this period were: Andrew Gibb Maitland (1896-1926, Fig. 1); Torrington Blatchford (1926-1934); Frank G. Forman (1934-1944); H. A. (Matt) Ellis (1945-1961), and J. H. (Joe) Lord (1961-present).

Until 1961 the geologists practised in all fields of geology, with emphasis on geological mapping and examination of mineral resources. It was excellent general training for geologists, but without opportunity to specialize in any particular field. After the expansion in 1961, geologists were recruited for their particular experience or training in specific fields of geology. The Survey now has divisions covering most facets of geology, namely hydrogeology (13 geologists), engineering geology (4), mineral resources (9), regional geology (9), sedimentary geology (9) and sections in petrology (3), palaeontology (3), geophysics (2), geochemistry (1), environmental geology (2) and technical information (4).

Following the 1961 expansion of the Geological Survey special emphasis has been placed on regional geological mapping to ensure that the geology of the whole State is mapped at the useful 1:250 000 scale. The field work for the last of the 163 maps should be completed in this 150th Anniversary year. In this arid State hydrogeology has become a major function of the Survey in the search for groundwater for town supplies, mining operations, and for farmers and pastoralists. In the future more detailed geological mapping is proposed for areas covering mineralized belts.

Over the last 18 years, while efforts have been mainly directed towards systematic geological mapping, the Survey may have lost close contact with the prospector and exploration companies in the field, but this was necessary if the mapping were to be done in a reasonable time. To help restore this contact it is now intended to open regional offices at several major country centres.

The Commonwealth Government first became involved in the geology of this State with the passing of the Northern Australian Survey Act of 1934, which gave authority to establish the Aerial, Geological and Geophysical Survey of Northern Australia (AGGSNA). The first meetings of this organization were held in June 1934 and field parties started work in April 1935. AGGSNA consisted of the Commonwealth (Northern Territory), Queensland and Western Australia, who agreed to start the three year programme of work in each region north of 22°S latitude. The Commonwealth contributed \$150 000 and each State \$75 000 to search for



metallic minerals, particularly gold. A geological party was established in each State and two geophysical parties which investigated problems as and where required. The programme in Western Australia extended beyond the planned three years with field work being completed in 1938. The unit was disbanded in June 1939.

Some 64 reports on the Western Australian work were published. The young geologists involved in AGGSNA were later to become leaders in the profession. Dr W. G. Woolnough was the Commonwealth geological advisor for the creation of AGGSNA and there is little doubt that his enthusiasm was largely responsible for the Commonwealth Government establishing the Bureau of Mineral Resources (BMR) immediately after World War II

The BMR has been a major contributor to the geology of this State, particularly prior to the expansion of the Survey. Earlier the BMR carried out all geological mapping in the sedimentary basins while in more recent years it has contributed to joint mapping parties. In the field of geophysics the BMR has been particularly active with regional aeromagnetic and gravity surveys.

#### Educational institutions

As interest in geology heightened with the gold discoveries of the 1890s, a demand arose for the subject to be taught at the limited educational facilities available at that time. In 1900 Perth Technical School offered courses in geology and mineralogy and these were probably the first formal classes established. The lecturer was F. C. Stockwell.

The School of Mines of Western Australia, under the control of the Department of Mines, was opened at Coolgardie in November 1902, and then was moved to Kalgoorlie at the end of 1903. Geology and mineralogy were amongst the first courses offered. The School of Mines, because of its locality, became a centre for mining geology, although it was not until 1947 that a full associateship course was established.

The lecturer who probably deserves most recognition is Dr C. O. G. Larcombe, who joined the School in 1907 and remained there until early 1934. He was responsible for planning the Mineral Museum which opened on 7 December 1907, and is a feature of the School of Mines today. Larcombe was particularly interested in petrology and mineralogy, and he also acted as petrologist to the Geological Survey of Western Australia from 1922 to 1928. His best known publication was "The Geology of Kalgoorlie with Special Reference to the Ore Body" published in 1911 by the Australasian Institute of Mining Engineers.

The School has always maintained an active interest in the geology of the Kalgoorlie area. Larcombe contributed many papers on this topic, while Dr F. L. Stillwell, on loan from the Commonwealth Scientific and Industrial Research (CSIR), used the School as a base for his study in 1927 and 1928 of the "Geology and Ore

Deposits of the Boulder Belt, Kalgoorlie" published as Geological Survey Bulletin 94. In later years G. S. Compton and W. H. Cleverly were in charge of the geology department. When the Western Australian Institute of Technology (WAIT) took control of the School of Mines at Kalgoorlie in 1969 the Geology Departments of the two establishments were amalgamated, with the head of the Geology Department being at WAIT near Perth.

WAIT was established in 1967 with an associateship course in geology. This course, which was upgraded to a degree course in 1975, is designed to educate in the practical aspects of geology, but there has been insufficient time as yet for the graduates to make their mark.

When a university was first founded in this State, limited finance restricted its scope to the establishment of only seven chairs, exclusive of Agriculture which was endowed. There was much discussion and lobbying as to which disciplines should be represented. The first six decided upon were Mathematics and Physics, Mining (now dropped) and Engineering, Biology, History and Economics, English, Chemistry, leaving the seventh chair to be either Classics, Education or Geology. Voting was eventually deadlocked between Classics and Geology, leaving the Chancellor, Sir Winthrop Hackett, a well known supporter of the Classics, with the casting vote. To the Senate's surprise the Chancellor gave his vote to Geology because of the importance of the mining industry to this State, a fact which was realized in 1912 but is often overlooked today.

By the time the University opened in 1913, Walter George Woolnough (Fig. 2) had been appointed the first Professor of Geology at the University of Western Australia. He had studied at the University of Sydney under the father of geology in Australia, Professor Sir Edgeworth David, and had gained the first D.Sc. awarded by that University. He travelled extensively in Australia and Fiji and had lectured at the Universities of Sydney and Adelaide. As the first geology professor in this State he was an excellent choice, being a lucid lecturer and devoted to his students to whom he gave a good grounding in practical geology.

He resigned in 1919 and worked on economic mineral deposits in all areas of Australia. In 1927 he was appointed Geological Adviser to the Commonwealth Government, a position he was reluctant to leave on reaching retirement age in 1941, having laid the foundations for the development of the Bureau of Mineral Resources. He pioneered the use of aerial photography for geological purposes in Australia, gave close attention to the oil possibilities of the north west of this State, in particular the Exmouth Gulf area, and was responsible for the investigation of Yampi Sound iron ore deposits.

The Geology Department of the University had been given a solid foundation by Woolnough, but on his resignation it was decided, due to the shortage of finance, to abolish the chair and to appoint a lecturer-in-charge instead. This



Figure 2.—Walter George Woolnough, the first professor of geology at the University of Western Australia.

decision allowed the estimated expenditure for the geology department to be reduced from \$3176 in 1919 to \$1080 in 1920.

Edward de Courcy Clarke was appointed to the position of Lecturer but did not commence duty until 1921. He was a graduate of University College, Auckland, and had joined the Geological Survey of Western Australia in 1912 as a field geologist. He travelled extensively in Western Australia and produced six bulletins regarding his investigations on the goldfields, and had made a reconnaissance survey with H. W. B. Talbot of the country between Laverton and the South Australian border. He enjoyed field work and practical geology, spending 356 days in the field around Meekatharra in 1914.

As a lecturer his enthusiasm for practical geology was always evident and he was a worthy successor to Woolnough. In 1930 the chair of geology was re-established; Clarke was appointed and occupied it until his retirement in 1948. He was a dedicated man with simple tastes and an ability to encourage and inspire his students, whose interests he placed above all others. He consolidated the Geology Department and established its reputation. His main interest was Precambrian geology, although in the latter

part of his career he was co-author with his staff of many papers on the geology of younger rocks.

Clarke was succeeded by one of his outstanding students, Rex T. Prider, who carried on the traditions established by Clarke until he retired in 1975. Peter G. Harris, another New Zealand graduate, now occupies the chair.

During the past 30 years the Geology Department has gradually expanded to meet the demand for more geologists and research. One might expect that this Department of the major University in Western Australia would, because of the huge mineral wealth in the State, have developed into a major centre for research into the Precambrian rocks and mineral deposits. This has not eventuated although such centres have now developed in other Australian Universities.

#### Consulting and company geology

The discovery of the Golden Mile near Kalgoorlie in 1894 created world-wide interest in Western Australia, resulting in visits by overseas consulting geologists and mining engineers, as well as government and academic geologists. Many of these persons wrote of their observations and opinions. Amongst those who published papers within the first ten years of the discovery were: G. J. Bancroft, H. Y. L. Brown, Y. F. Bulman, A. F. Calvert, S. W. Tard, A. Carnot, A. G. Charlton, C. Chewings, H. B. Corbin, William Frenchville, E. Halse, H. G. Holroyd, Herbert C. Hoover, J. F. Kemp, P. M. Krause, P. Krusch, Baron Sloet van Oldrietenburgh, E. F. Pitman, T. A. Rickard, Bergrath Schmeisner and Brenton-Symons. After the initial flurry, from about 1910 onwards more detailed geological examinations were made by consultants, who stayed longer. Many of their reports were no doubt confidential to the companies concerned. Amongst these were Dr Malcolm McLaren (representing the London Mining House, Gold Fields), Dr J. A. Thomson, R. Lockhart Jack and T. Esdaille.

Due to World War I and the depressed conditions for gold in the aftermath, little work is recorded by private consultants or companies in this period. In 1928 Malcolm McLaren returned to look at the Lake View and Star Mine at Kalgoorlie and the Moonlight-Wiluna Gold mine at Wiluna. Probably through him a Geological Section was established at the Lake View and Star Mine in 1929 with a young geologist from Canada, R. F. Playter, in charge, assisted by Harold Jensen. This was probably the first company geological office established in this State.

In 1933 Western Mining Corporation (WMC) was formed by William Sydney Robinson, who was a strong supporter and instigator of a scientific approach to exploration. This has certainly been proved profitable when one looks at WMC's existing mines and prospects (Yeelirrie, Roxby Downs and Benambra). A Geological Department was established with J. D. Campbell, H. W. B. Talbot, A. Blatchford and K. J. Finucane as the first geologists.



Robinson then engaged D. McLaughlin, Professor of Economic Geology at Harvard, as consultant to the company to introduce modern methods of exploration, which he had developed, into Western Australia. McLaughlin assembled a large group of geologists who had trained under him at Harvard. H. E. McKinstry, G. K. Gustafson and F. Miller were consultants for the company from 1934 until 1936, while H. J. C. Connolly was appointed chief geologist and Haddon F. King, Frank A. Moss and R. F. Thyer joined as permanent staff members. This probably still remains the most talented group of geologists ever assembled for mineral exploration in Australia and WMC retained more geologists than any other company operating elsewhere in Australia at that time.

WMC was the first organization to apply aerial photography to mineral exploration in Australia. This technique had been suggested by South African interests in the company, and the photographic section was under the control of Wing Commander Laws, a former Royal Flying Corps pilot. Some of the experience and techniques developed were used in World War II. The group carried out factual surface mapping and interpretation. Geophysical methods were considered and ground magnetic surveys were done.

In addition, the group examined existing and former mines for extensions or repetitions. These included the southern extension of the Golden Mile, Norseman, Great Fingall (Day Dawn) and the Cosmopolitan (Kookynie). Through pursuing this policy with an active, progressive geological team, WMC has become one of Australia's major mining companies, and with such finds as mentioned earlier, it has proved that geologists as well as prospectors do find ore bodies.

After World War II, other companies such as BHP, Rio Tinto and Zinc Corporation, began to employ exploration geologists in this State and in the oil and uranium booms of the early 1950s, companies and consultants established geological departments. In the mineral boom of the 1960s and early 1970s geological sections became essential for all active companies, some of the larger companies having 60 to 80 geologists engaged at the peak of the boom.

While a number of geological consultants visited this State for varying periods, it is believed that K. J. Finucane (Fig. 3), a Western Australian graduate with wide experience, was the first to establish himself as a permanent resident consultant in 1939. He is still practising some 40 years later. In the early 1950s Frank G. Forman, a former Government Geologist, established a consultancy; he was followed by E. P. Utting and S. A. Tomich later in the decade.

The mineral boom of the 1960s saw many local and overseas individual consultants and consulting firms establish themselves in Western Australia. With the passing of the boom in 1972 some moved on, some have turned to contract work or positions with companies, while about 30 continue to practise.



Figure 3.—Kevin J. Finucane, the first resident consultant in Western Australia.

### Specialized branches of geology

With the rapid development of geology in the last 2 or 3 decades many new branches or associations with geology have developed particularly in the search for minerals. These include geophysics, geochemistry, geobotany, palaeomagnetism, geochronology and others, which will eventually require a history of their own. Only the original major branches of geology are considered below.

#### *Petrology*

Petrology has a longer history in this State than any other branch of geology. This resulted from the great interest developed here and abroad with the discovery of gold at Kalgoorlie, and the necessity to unravel the petrological and structural history, a problem which is still receiving attention.

Many geologists visiting the new goldfields found great interest in the petrology and mineralogy of the telluride ores and their host rocks which led to the publication of numerous short papers while no doubt many others were held as confidential in company reports.

The first published descriptive petrology was by G. W. Carr of the Geological Survey of New South Wales on a suite of rocks from Kalgoorlie. However E. S. Simpson, although strictly a mineralogist and analyst, had joined the Geological Survey in 1897 and was contributing to petrological knowledge.

About 1910 microscopic petrology flourished with Dr J. A. Thomson, who accompanied Dr Malcolm McLaren on a lengthy consulting visit, contributing papers. Dr C. O. G. Larcombe, at the School of Mines, studied the rocks of the Golden Mile, and R. A. Farquharson joined the Survey as petrologist in 1911. After Farquharson's resignation in 1922, Larcombe acted as petrologist for the Geological Survey until 1928. The University was the next to develop petrology with the appointment of Rex T. Prider as an assistant lecturer in 1934. Later he went on to Cambridge to study for his Ph.D. and returned to the University, where he made many major contributions to the petrology of this State. The University continues to be well known for its petrological research.

Sedimentary petrology was studied at the University of Western Australia with the appointment of Dr Dorothy Carroll in 1941 as a Research Fellow. After her departure in 1943, the University did not appoint a replacement until Dr J. J. E. Glover joined as a Lecturer in 1955 and he has continued to study and teach this branch of petrology.

After Farquharson's resignation the Geological Survey did not appoint another petrologist until Dr A. F. Trendall joined the staff in 1962. The Survey's Petrology Section has now been expanded to three petrologists. Over the last 10 years joint petrological and geochronological studies with John de Laeter of W.A.I.T. have been carried out and have made a major contribution to this work in Western Australia (see de Laeter and Trendall, this volume).

#### *Palaeontology*

This branch of geology in Western Australia illustrates the development of specialization in the science. In the last century there were very few palaeontologists, but generally they examined most groups of fossils. Today, in contrast, palaeontology is a highly specialized profession, with some workers spending their lifetime studying a few genera of one particular order. This applies particularly to the study of foraminifers, due to their economic value in oil exploration.

In Western Australia the early palaeontology was of a very general nature and studied mainly by overseas workers to whom suites of specimens were sent. F. T. Gregory, over the period 1846-1861, collected fossils particularly from the Irwin and Gascoyne Rivers and Geraldton areas. The Gregory brothers made the first fossil determinations and showed the results on their geological map of 1847. Other collections of fossils were sent to England, and studied by Charles Moore, Reverend W. B. Clarke and W. H. Huddleston and reported upon in the Quarterly Journal of the Geological Society of London.

In the latter part of the 19th century E. T. Hardman and H. P. Woodward devoted some of their time as Government Geologists to the study of fossils and encouraged other specialists, such as Arthur H. Foord (brachiopoda and mollusca), R. Kidston (plant remains), H. Alleyne Nicholson (stromatoporoids) and George J. Hinde (corals and bryozoa) to become involved.

With the establishment of a permanent Geological Survey, R. Etheridge Jr., Curator and later Director of The Australian Museum, Sydney, became the honorary palaeontologist and together with others, including F. Chapman, palaeontologist, National Museum, Melbourne, and W. Howchin, palaeontologist, University of Adelaide, had numerous papers published in the Geological Survey's bulletins.

In 1908 Ludwig Glauert was engaged by the Survey as a palaeontologist, apparently the first employed full-time in this State. He prepared a catalogue of Western Australian fossils and appeared to have stimulated more work by outside specialists including E. A. Newell Arber and Rex W. Brettnall. Unfortunately Glauert resigned within two years to join the Western Australian Museum, where he continued for many years producing palaeontological papers published mainly in the Journal of the Royal Society of Western Australia.

The Geological Survey did not engage another palaeontologist until 1962; the staff of the palaeontology section has now increased to three. The palaeontologists provide general palaeontological assistance to the geological staff; palynology is particularly useful for stratigraphic control of the extensive groundwater exploratory drilling programmes carried out by the Survey.

The University of Western Australia did not specialize in palaeontology until Dr Curt Teichert was appointed a Research Fellow in 1937. During his eight years at the University, Teichert was responsible for considerable research in palaeontology and stratigraphy and his papers drew world-wide attention to this State and in particular to its oil potential. After Teichert left, the University continued to have palaeontologists on the staff, while palynology was added later to its area of research and teaching. Dr B. E. Balme, who had done an Honours thesis on palynology of the Collie coals in 1948, returned to the University some ten years later to become a Lecturer (later Reader), specializing in palynology.

In recent years the Western Australian Museum has studied vertebrate and Quaternary palaeontology.

#### *Mineralogy*

When the Geological Survey was formed provision was made for a mineralogist and assayer. In 1897 Edward S. Simpson, graduate in mining and metallurgy from the University of Sydney, was appointed to the position. He was destined to stay with the Government for 42 years and in this time made a major and outstanding contribution to his field.

As mineralogist and assayer he acted as chemist to the Department of Mines. In addition to handling work of a routine nature, he became involved in the chemistry and petrology, as well as the mineralogy, of areas being studied by the Survey. In particular he unravelled the rock types of the Golden Mile at Kalgoorlie. In 1919 he was awarded a D.Sc. from the University of Western Australia for his thesis



"The Minerals of Western Australia". Throughout his life he continued to study and accumulate information on the minerals of this State.

In 1922 he was made Government Mineralogist and analyst in charge of what is now known as the Government Chemical Laboratories, which conducts a wide variety of analytical work for numerous Government Departments. Despite these added responsibilities, he continued to promote and foster mineralogy, the study of which he retained as a major operation in the laboratories.

He published over 100 scientific papers, provided an immense amount of data for Survey publications and was working on his opus magnum summarising the mineralogical knowledge of the State when he died suddenly in August 1939, only a few months prior to retirement. His work was completed by colleagues and "Minerals of Western Australia" was eventually published in three volumes by the Government over the period 1948 to 1952. This has proved to be an invaluable reference book on the minerals of the State and their occurrence, to assist students, prospectors and exploration geologists.

Since the passing of Simpson and his immediate successors the study of mineralogy has declined. The Government Chemical Laboratories have now grown to a size where they could be decentralized to the Departments for which they work.

As mineralogy forms an integral part of petrology, geochemistry and geochronology, it continues to be studied at the University of Western Australia but there has been no strong specialization in the subject.

In 1963 the Commonwealth Scientific and Industrial Research Organization (CSIRO) opened a branch of their Division of Mineralogy in Perth. A very strong and active research section on the problems of mineralogy and mineralization in this State has been developed and is contributing to our development.

### Geological museum

Rev. C. G. Nicolay, started the first collection of rocks, minerals and fossils at Fremantle in 1881. Nicolay was apparently very keen and established a good geological collection representative of the colony. To the best of his ability he tried to identify and report on the rocks and minerals that he collected or acquired. He did receive criticism from one Government Geologist of the day, E. T. Hardman, who apparently considered him to be incompetent in his identifications.

The collection assembled by Nicolay was housed at Fremantle and known as the Geological Museum. In 1889 it was transferred to Perth, to form the original collection of the Western Australian Museum.

Several collections of minerals including excellent specimens of gold and tellurides from the Kalgoorlie area were sent to exhibitions in England and Europe, but were never returned.

When Maitland formed a permanent Survey in 1896, he and his staff built up a collection of rocks and minerals. This collection far outgrew the Museum collection, and in 1908 the Government decided that the two collections, both at that time housed close together, should be amalgamated under the direction and custody of the Government Geologist, but displayed in a gallery attached to the Museum. In the amalgamated collection there were about 10 000 registered specimens of which only about 15 per cent had been derived from the Museum's collection.

The collection continued to grow until 1966 when the Museum required the gallery for other purposes and the Survey was required to remove the collection.

It was placed in store at the Survey's core and cuttings library until 1971 when Mineral House was completed with limited space for a Museum. Now nearly 1 000 specimens of Western Australian rocks, minerals and fossils are displayed in the Survey's Museum, while the remainder are still in store. The catalogue of the whole collection is now being placed on computer and retrieval of any particular specimen is relatively easy if required.

The Western Australian Museum has concentrated on a collection of vertebrate and Quaternary fossils. It also has a collection of meteorites which attracts world-wide recognition but no collection of rocks or minerals.

### Conclusion

This brief review of the development of geology in the State shows that the profession has gained greater strength in the last 20 years than in the previous 130 years. This is the result of the extensive mineral development of recent times and the general acceptance that geology is necessary to locate, to explore, and to develop mineral deposits.

The growth of the profession in this State appears at first glance to be very satisfactory, until comparison is made with that of other States. In the Western Australian Geological Survey there is only one geologist per 40 000 km<sup>2</sup>, which is the lowest density of all the Australian States. Queensland has one geologist per 24 000 km<sup>2</sup>, while Tasmania has one per 2 100 km<sup>2</sup>. Thus it is apparent that this situation can and should be improved as soon as finance can be made available. There is need for expansion of teaching, both at secondary and tertiary level, and research into many aspects of geology. This State should become a centre for study of both Precambrian geology (metallic minerals) and sedimentary geology (oil and gas) by the establishment of research centres, particularly in association with the tertiary institutes.

As this State, and Australia generally, depends largely upon minerals, it is the duty of the State to arrange the financing of these proposals. If this is done, our economic future will be assured and at Western Australia's bicentennial anniversary, the State will be known as a centre of geological research and geological activity, as



well as having developed into the major mineral production and processing region in Australia.

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### References

Numerous references have been consulted but, in consideration of space only the major ones are listed. However from those given, all others may be located if required. For instance, I. R. Williams has assembled nearly 1 000 references on the Eastern Goldfields of which many of the earlier ones have been consulted but are not quoted here.

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